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Hepaticae of Puerto Rico

V. CERATOLEJEUNEA

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(WITH PLATES 19 AND 20)

Ceratolejeunea is one of the most natural genera of the Lejeuneae, and its distinctive characters were appreciated long before it was formally recognized as a genus. Apparently the West Indian *C. cornuta* (Lindenb.) Schiffn. * is the species which first appears in the literature. This was originally described as a *Jungermannia* † but a few years afterwards was referred to the genus *Lejeunea* by Nees von Esenbeck.‡ Meanwhile Dumortier had placed it in his newly proposed genus *Colura*, § of which the type species was *Jungermannia calyptrifolia* Hook. The two species are totally distinct in their vegetative structure, having little in common except their horned perianths, and even in these there are structural differences of importance. In spite of these facts, they are still kept together in the Synopsis Hepaticarum under the section *Ceratanthae* of the genus *Lejeunea*.‖ The authors, however, divide this section into two subgroups, *Genuinae* and *Aberrantes*. The first of these corresponds exactly with the genus *Ceratolejeunea*, as now understood by most writers, and includes *C. cornuta* and about fifteen of its immediate allies. The second is a much more artificial group

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* Bot. Jahrb. **23**: 583. 1897.

† Lindenberg, Nova Acta Acad. Caes. Leop.-Carol. **14**, suppl.: 23. 1829.

‡ Naturg. der europ. Leberm. **3**: 265. 1838.

§ Recueil d'Obs. sur les Jung. **12**. 1835.

‖ *L. c.* 399. 1845.

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and includes species belonging to the two modern genera *Colurolejeunea* and *Leptolejeunea.* Many years later Trevisan * revived Dumortier's genus *Colura,* giving it the same limits as the section *Ceratanthae* of the Synopsis. The subsequent history of *Ceratolejeunea* is the same as that of other genera of the Lejeuneae; it was first described as a subgenus by Spruce † and afterwards elevated to generic rank by Schiffner. ‡

Ceratolejeunea is composed entirely of tropical and subtropical species and attains its highest development in the mountainous forests of America. A few species, however, are known from paleotropic regions and from the islands of the Pacific. The plants usually grow on rotten logs or on the bark of trees or shrubs but sometimes occur on shaded rocks or even on living leaves. As a rule, a given species is more or less particular in its choice of a substratum. In some cases the plants grow mixed with other hepatics but it is much more usual to find them in pure mats, which sometimes measure several feet in length. The stems are at first prostrate and cling closely to the substratum, but in old mats the plants become depressed-cespitose and often stratified in appearance and the branches assume a more or less parallel position.

Although classed among the Lejeuneae Schizostipae, the species of *Ceratolejeunea* are more robust than is usual in this group and are further distinguished by their olive-brown color and by their glossiness. The color is due to a pigmentation of the cell-walls and is sometimes pronounced enough to make the plants appear almost black; under other circumstances it is hardly sufficient to mask the green color of the chloroplasts. In their general appearance the plants bear a strong resemblance to certain genera of the Holostipae, such as *Lopholejeunea* and *Odontolejeunea.*

The leaves are imbricated, although rarely densely so, and the lobe is broad and falcate, spreading widely from the axis. In the majority of cases the lobe is convex and the apex more or less reflexed. The antical margin is rounded except in the basal region, but the postical margin is more variable, being sometimes slightly rounded, sometimes nearly straight and sometimes distinctly incurved. The apex is usually broad and blunt but is frequently abruptly apiculate or acute. In some cases the margin of the lobe is entire throughout or indistinctly crenulate from projecting cells, in other cases it is more or less toothed, especially in the apical region, and in a few species it is sharply spinose. The leaves are exceedingly variable in certain species, and the degree of marginal dentation must always be used with caution as a diagnostic character.

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* Mem. r. Ist. Lomb. III. 4: 401. 1877.

† Hep. Amaz. et And. 198. 1884.

‡ Engler & Prantl, Nat. Pflanzenfam. 1^3: 125. 1893.

Except near the base of the lobe, the leaf-cells are more or less convex, and their walls are strongly thickened throughout. The middle lamella appears as a fine but distinct line and is clearly visible without the use of reagents (PLATE 19, FIGURES 5, 15). The thickening is deposited upon this lamella in the form of a layer and is practically uniform over both horizontal and vertical walls except for the scattered pits connecting the cells (FIGURES 6, 16). Viewed from the surface of the lobe, the thickenings appear in the form of large and often confluent trigones with occasional intermediate thickenings. The degree of thickening often varies in a single species, and is apparently dependent upon external conditions. Ocelli can frequently be demonstrated; they differ from ordinary cells in their larger size, in their thin walls and in their more oily contents (PLATE 20, FIGURE 7). In the majority of the species they occur singly or in small irregular groups near the base of the lobe, but in at least one species they form a short row simulating a nerve. In certain species, the number and even the occurrence of ocelli is subject to variation, some of the leaves failing to develop them altogether.

The lobule when normally developed conforms very closely to that described for *Prionolejeunea* and for certain other genera of the Lejeuneae, the hyaline papilla being proximal in position and the apical tooth short and curved (PLATE 19, FIGURE 18; PLATE 20, FIGURES 10, 11, 24). The free margin of the lobule is involute to beyond the apex and appressed to the lobe, the apical tooth and the sinus helping to form the opening into the water-sac. The lobule is inflated throughout and is more or less curved in the outer part (PLATE 19, FIGURES 12, 13; PLATE 20, FIGURES 1, 3, 19).

The type of lobule just described is, however, subject to two modifications, both of which tend to increase the size of the water-sac. In the first the keel is so strongly arched that it is approximately semicircular in outline (PLATE 19, FIGURE 2). At the same time the free portion of the lobule, which is involute throughout its entire length and appressed by its surface to the lobe, shows a distinct fold of involution almost as strongly arched as the keel itself. The result is that the water-sac becomes almost spherical in shape and exhibits a very minute opening. The free margin of such a lobule is rounded and the apical tooth shorter than usual and nearly straight (FIGURE 9); the hyaline papilla maintains its usual position and appearance. With this first modification of the lobule, the lobe is sometimes as large as in ordinary leaves, but is often considerably reduced in size.

In the second modification of the lobule the peculiarities of the first are exaggerated, and the water-sac is several times larger than in normal leaves. Enlarged water-sacs of this type are described as " utriculi " and occur singly or in a pair at the base of a branch (PLATE 19, FIGURES 1, 4, 12, 14; PLATE 20, FIGURE 4). The keel is here so strongly arched that it forms rather more than a semicircle and is quite a little longer than the free margin. The free portion of the lobule is in the form of a small lamina, which varies in shape from rectangular to trapezoidal and is usually cut off square at the end. This lamina is revolute and concealed within the water-sac. Sometimes it is slightly concave and helps to form an oval opening into the sac; sometimes it is strongly concave and the opening becomes more nearly circular. The apex and the hyaline papilla are essentially the same as in the second modification. The free portion of the lobe is very greatly reduced in size.

Certain species constantly develop the normal type of lobule or produce the spherical modification only in exceptional cases; others show a preference for the spherical form but sometimes revert to the normal; still others exhibit both normal and spherical lobules in almost equal number. In certain species the utriculi are apparently never developed; in others they occur with greater or less frequency. In all probability the development of both spherical lobules and utriculi is dependent upon external conditions, but at the present time no definite statements to this effect can be made. Of course, under some circumstances the lobules fail to develop or present a very rudimentary appearance.

The underleaves are attached by an almost straight line of insertion and often show a rudimentary disc in the basal region, from which the rhizoids develop. They vary in shape from orbicular to broadly reniform, and the base varies from cuneate to deeply cordate. In the majority of the species the underleaves are bifid; in a very few species they are undivided. The margin is commonly entire.

The inflorescence in the genus seems to be almost equally divided between autoicous and dioicous. The archegonial branch varies greatly in length in most of the species, but is invariably subtended by one or two innovations, which are themselves often floriferous. The bracts are usually connate with the bracteole and sometimes with each other (PLATE 20, FIGURE 17). They are rarely much larger than the leaves and are often perceptibly smaller.

The perianth is perhaps the most striking feature of the genus. It is more or less obovoid in shape and abruptly narrowed into a short but distinct beak. In the lower part it is nearly terete; in the upper part the antical surface is plane or nearly so, but there are two distinct lateral keels and two postical keels. Each of these four keels grows out beyond the beak in the form of a hollow horn, which sometimes remains short and sometimes becomes nearly as long as the remainder of the perianth (PLATE 19, FIGURES 1, 12; PLATE 20, FIGURES 1, 2, 21). Such a horn is formed by the rapid growth and division of the cells in the upper part of the keel and shows at maturity a group of small and thin-walled cells at its apex, very different from the thick-walled cells found elsewhere in the perianth. On account of the delicacy of these cells, the horns often become irregularly torn at the apex but it is doubtful if they are ever normally toothed or spinose. In rare instances a fifth horn grows out from the base of one of the other horns and is supplementary to it. Of course, a five-horned perianth of this type is very different from that found in such a genus as *Leptolejeunea*, where the fifth horn is always antical in position.

Specialized organs of vegetative reproduction have not yet been observed in *Ceratolejeunea*. It is not unusual, however, for a leaf-cell to give rise directly to a leafy shoot or propagulum without the interpolation of a protonemal structure. This takes place more readily in a leaf which has become detached but sometimes occurs in an intact leaf. Propagula of this type are homologous with those described for *Plagiochila*.

Five species of *Ceratolejeunea* have been recorded from Puerto Rico. Three of these are mentioned in Hampe and Gottsche's list of Schwanecke's hepatics; namely, *L. ceratantha*, *L. patentissima* and *L. variabilis.*[*] The specimens referred to *L. ceratantha* have been examined by Stephani and also by Schiffner. Stephani makes them the type of his new *Ceratolejeunea Schwaneckei;* Schiffner finds in them a mixture of two species, the one indeterminable and the other referable to *L. variabilis.*[†] There is no very good evidence, therefore, that *L. ceratantha* has been really found on the island. In the paper on Puerto Rico hepatics published many years later by Stephani, two other species, *L. cornuta* and *L. spinosa* are added from the collections of Sintenis,[‡] but the specimens referred to *L. cornuta* were afterwards described as *Ceratolejeunea Sintenisii* Steph. *L. cornuta*, therefore, should also be considered a doubtful member of the flora. In the collections made by the writer on El Yunque, both *C. spinosa* and *C. Schwaneckei* occur in abundance, and there are also specimens of a third species which is apparently undescribed. Heller's specimens of this genus are mostly sterile but add a few fragments of what seems to be *L.* (*Ceratolejeunea*) *brevinervis* Spruce. Seven species, therefore, are known with more or less certainty from the island, and it is probable that several others remain to be discovered.

CERATOLEJEUNEA SPINOSA (Gottsche) Steph.

Lejeunea spinosa Gottsche; G. L. & N. Syn. Hep. 402. 1845.

Colura spinosa Trevis. Mem. r. Ist. Lomb. III. **4**: 402. 1877.

Lejeunea (*Cerato-Lejeunea*) *spinosa* Spruce, Hep. Amaz. et And. 211. 1884 (excluding specimens described).

Ceratolejeunea spinosa Steph. Hedwigia **34**: 238. 1895.

Dark olive-green or brownish, growing in depressed tufts: stems 0.17 mm. in diameter, prostrate and loosely adherent to the substratum, irregularly pinnate, the branches obliquely spreading, usually short but otherwise similar to the stem: leaves imbricated, the lobe more or less convex and inflexed at the apex, falcate-ovate, 0.85 mm. long, 0.6 mm. wide, antical margin nearly straight near base and stretching partly or wholly across axis, then somewhat curved to the apex, postical margin straight or nearly so, apex broad but usually acute, margin coarsely and irregularly toothed in the apical region, teeth mostly 8 to 10, variable in size, the smallest consisting of single projecting cells, the largest about three cells long and two cells wide at the base; lobule normally of the spherical type but often poorly developed, 0.25 mm. long, 0.2 mm. wide, hyaline papilla in a distinct depression, apical sinus very short and almost straight; utriculi occasionally present; cells of lobe averaging 19 μ at the margin, 23 μ in the middle and 46 × 28 μ at the base, trigones large and often confluent, triradiate and rounded at the ends of the rays, intermediate thickenings occasional, subrotund in outline; ocelli usually absent but sometimes occurring singly at the base of the lobe: underleaves distant, orbicular, 0.35 mm. long, bifid about one half with erect triangular lobes separated by an acute to obtuse sinus, margins entire or vaguely crenulate or angular on the sides: inflorescence dioicous: female branch variable in length, sometimes much abbreviated, the flower subtended by one or rarely two simple and sterile innovations; bracts complicate, obliquely spreading, the lobe ovate, 1.1 mm. long, 0.7 mm. wide, acute, antical margin more strongly curved than the postical, irregularly spinose-dentate except near the base, the teeth mostly 10 to 20, lobule lanceolate to narrowly ovate or oblong, 0.75 mm. long, 0.25 mm. wide, margin toothed but with relatively fewer teeth than the lobe, apex acute to obtuse; bracteole connate on both sides, ovate, 0.75 mm. long, 0.4 mm. wide, bifid about one third with erect, triangular and acute lobes and a narrow sinus, margin as in the bracts but with smaller and fewer teeth; perianth immersed (except the horns), obovoid, 1 mm. long, 0.5 mm. wide, surface roughened by the convex cells, especially along the keels, beak short, horns about half as long as the main body of the perianth (0.35 mm.), contracted near the base, inflated and enlarged toward the rounded or bluntly pointed apex, more or less compressed, smooth, the two postical horns obliquely spreading, the two lateral widely spreading: ♂ inflorescence usually occupying a short branch, more rarely terminal on a longer branch; bracts in one to six pairs, inflated, shortly and subequally bifid with obtuse divisions and strongly arched keel; bracteoles at base of spike, similar to the underleaves but much smaller; antheridia single or in pairs: mature sporophyte not seen. (PLATE 19, FIGURES 1–11.)

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[*] Linnæa **25**: 355, 356. 1852.

[†] Bot. Jahrb. **23**: 582. 1897.

[‡] Hedwigia **27**: 285, 291. 1888.

On the bark of trees or on prostrate logs, more rarely on living leaves. El Yunque, *Evans* (*42*, *61*, *74*, *97*, *167*). Originally collected in Puerto Rico by *Sintenis* (*34*, *35*). Widely distributed in the West Indies, the type locality being St. Kitts, where it was first found by *Breutel.* It has also been reported from the following islands: Guadeloupe, *L'Herminier;* Dominica, *Elliott*, *Lloyd;* Martinique, *Duss;* St. Vincent, *Elliott;* Cuba, *Wright.* The specimens from the Andes, described by Spruce as *L. spinosa*, do not belong to this species.

C. spinosa is characterized by its dentate leaves, usually destitute of ocelli, by its strongly inflated and subspherical lobules, by its small, orbicular underleaves, by its dioicous inflorescence, and especially by the peculiar horns of its perianth, which are enlarged and inflated near the tips and yet more or less compressed. In most species where the horns are elongated, they are terete and taper gradually to a point.

Under the name *C. spinosa* var. *flagelliformis*, Stephani * has described a peculiar but sterile plant from Martinique collected by Duss. It differs from the typical *C. spinosa* in its much looser habit, the leaves being distant and the branches slender and often microphyllous, in its lobules, which are either poorly developed or else conform to the usual type of lobule found in the genus, and in its underleaves, which are more deeply bifid. Female specimens of the same plant were collected by the writer on El Yunque (*101*), where it grew sparingly on bushes. In these specimens the underleaves are occasionally subcordate at the base. The plants present every appearance of being distinct from *C. spinosa*, but in the absence of perianths it would perhaps be unwise to separate them.

Ceratolejeunea valida sp. nov.

Olive-brown, growing in depressed mats: stems 0.17 mm. in diameter, elongated, irregularly pinnate, the branches usually short and widely spreading, not microphyllous: leaves imbricated, the lobe convex and inflexed at the apex, broadly falcate-ovate, 1.1 mm. long, 0.85 mm. wide, antical margin straight or nearly so near the base, then strongly arched to the apex, postical margin less strongly arched and almost straight near the keel, apex broad, sometimes rounded but usually minutely apiculate and often bearing one or two additional teeth, margin otherwise entire; lobule always conforming to the normal type, narrowly ovate in outline, strongly inflated, 0.17 mm. long, 0.09 mm. wide, keel more or less arched, slightly roughened from projecting cells, forming an obtuse angle with the postical margin of the lobe, free margin of lobule straight or nearly so, apical tooth short and slightly curved, hyaline papilla in a slight depression, sinus lunulate; utriculi frequent, occurring singly or in pairs at the base of a branch, sometimes attaining a length of 0.65 mm., free lamina strongly concave and forming a cylindrical canal leading into the sac; cells of lobe averaging 14μ at the margin, 23μ in the middle, and 40 × 28μ at the base, trigones large and often confluent, triradiate and mostly truncate at the ends of the rays, intermediate thickenings occasional, approximately rectangular or quadrate in outline; ocelli not developed: underleaves distant to slightly imbricated, nearly plane, orbicular, 0.6 mm. long, rounded at the base, bifid about one third with erect, acute or subacute lobes and a narrow sinus, margin entire, rhizoids when present springing from a rudimentary disc: inflorescence dioicous: female branch very variable in length, the flower subtended by a single, short and often floriferous innovation; bracts complicate, obliquely spreading, the lobe ovate to orbicular-ovate, 0.85 mm. long, 0.6 mm. wide, apex rounded, apiculate or subacute, margin entire or irregularly toothed near the apex, lobule ovate-lanceolate to obovate, 0.55 mm. long, 0.35 mm. wide, rounded to acute at the apex, margin entire or sparingly denticulate in the upper part; bracteole somewhat connate on both sides, broadly ovate or oblong, 0.75 mm. long, 0.6 mm. wide, bifid about one third with erect acute lobes and a narrow sinus, margin entire or with a few scattered teeth; perianth immersed (except the horns), obovoid, 1 mm. long, 0.6 mm. wide, surface roughened especially along the keels, apex broad and with a short beak, horns nearly half as long as the main body of the perianth (0.3 mm.), cylindrical or slightly compressed at the blunt apex, smooth, the two postical horns erect, the two lateral erect or somewhat spreading: ♂ inflorescence and mature sporophyte not seen. (PLATE 19, FIGURES 12–20.)

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* Hedwigia 34: 238. 1895.

On bushes. El Yunque, *Evans* (*91*).

It is with some hesitation that *C. valida* is described as new, partly because species are so difficult to define in *Ceratolejeunea*, partly because it is so closely related to the following species. Perhaps its most striking peculiarities are found in the leaf-cells with their extremely thick walls. When these cells are viewed from the surface, especially in a flattened leaf, they present an unusual appearance because their large trigones are truncate rather than rounded (FIGURE 15). The species is also noteworthy because it fails to develop ocelli and spherical lobules. These characteristics will help to separate it from *C. spinosa.* It also differs from this species in its entire or sparingly toothed leaves, in its larger underleaves, in its entire or less dentate bracts and bracteoles, and in the differently shaped horns of its perianth.

Ceratolejeunea brevinervis (Spruce)

Lejeunea (*Ceratolejeunea*) *brevinervis* Spruce, Jour. Linn. Soc. Bot. **30**: 342. *pl. 21. f. 6–9.* 1894.

On bark of trees and on rotten logs. North slope of the Luquillo Mountains, *Heller* (*1131 p. p., 4712 p. p.*). Also known from the following islands: Guadeloupe, the type locality, *L'Herminier;* Dominica, *Elliott;* Jamaica, *Evans.*

There is only one important respect in which *C. brevinervis* differs from *C. valida,* and that is in the possession of a false nerve running half way from the base to the apex of the lobe and consisting of a row of from six to ten ocelli. In some cases there is a second and shorter row lying next to the first. The ocelli average about 40 μ in length and seem to be entirely absent from the bracts. Heller's specimens are not typical, the horns of the perianth being shorter than usual, but this is probably because they are poorly developed.

CERATOLEJEUNEA SCHWANECKEI Steph.

Lejeunea ceratantha Hampe & Gottsche, Linnaea **25**: 356. 1852. (Not Nees & Mont.)

Ceratolejeunea Schwaneckei Steph. Hedwigia **34**: 237. 1895.

Varying in color from olive-brown to blackish, growing in depressed mats: stems 0.14 mm. in diameter, loosely appressed to the substratum, elongated, irregularly pinnate, the branches usually short and widely spreading, often with smaller leaves than the stem: leaves imbricated, the lobe convex and sometimes inflexed at the apex, falcate-ovate, 0.85 mm. long, 0.6 mm. wide, antical margin nearly straight near base, then strongly curved to the apex, postical margin varying from slightly outwardly curved to slightly incurved, often nearly straight, apex broad, sometimes rounded and entire, sometimes apiculate and sometimes with two to four irregular and scattered teeth, margin otherwise entire; lobule sometimes conforming to the normal type and sometimes spherical; normal lobule strongly inflated, ovate in outline, 0.17 mm. long, 0.12 mm. wide, keel arched, slightly roughened from convex cells, forming an obtuse angle with the postical margin of the lobe, free margin of lobule straight or nearly so, apical tooth short and blunt, somewhat curved, hyaline papilla in a scarcely evident depression; spherical lobules 0.2 mm. long, apical tooth short and rounded, papilla in a distinct depression; utriculi often present, singly or in a pair at the base of a branch, sometimes attaining a length of 0.5 mm.; cells of lobe averaging 14 μ at the margin, 22 μ in the middle and 35 × 22 μ at the base, trigones large and often confluent, triradiate and rounded at the ends of the rays, intermediate thickenings occasional, oval to rotund in outline; ocelli often but not always present, occurring singly or in a pair at the base of the lobe, averaging 46 × 28 μ, not developed in the bracts: underleaves distant to imbricated, plane or convex when seen from below, varying in shape from orbicular and rounded or even cuneate at the base to broadly reniform and cordate at the base, 0.25–0.5 mm. long, 0.25–0.85 mm. wide, bifid one third to one half, the sinus narrow and usually acute, the divisions erect, triangular, acute to obtuse, margin entire: inflorescence dioicous: female branch variable in length but rarely very short, the flowers innovating on one or on both sides, the innovations usually short and simple; bracts complicate, obliquely spreading, the lobes ovate and connate antically at the base, 0.85 mm. long, 0.5 mm. wide, apex rounded or apiculate, margin entire or sparingly and irregularly toothed in the upper part, lobule ovate to ovate-lanceolate, 0.6 mm. long, 0.2 mm. wide, rounded to acuminate at the apex, margin usually entire but sometimes with a few scattered teeth in the upper part; bracteole connate on both sides, broadly ovate to orbicular, about 0.6 mm. long, bifid about one third with erect and acute lobes and a narrow sinus, margin entire or with one or two scattered teeth on each side; perianth immersed (except the horns), obovoid, 1.1 mm. long, 0.6 mm. wide, surface slightly roughened especially along the keels, apex broad and with a short beak, horns about 0.25 mm. long, terete and gradually tapering to the acute or bluntly pointed apex, smooth, the two postical horns erect or slightly spreading, the two lateral suberect to widely spreading: ♂ inflorescence occupying a short branch or terminal on a longer branch, sometimes proliferating at the apex; bracts mostly in three to six pairs, imbricated, strongly inflated, shortly and subequally bifid, the lobes bluntly pointed; bracteoles present at base of spike, orbicular, bifid; antheridia usually borne singly: mature sporophyte not seen. (PLATE 20, FIGURES 1–18.)

On bark of trees or on logs, rarely on rocks or on living leaves.

El Yunque, *Evans* (*26, 32, 71, 81, 118, 146, 147, 159*). North slope of the Luquillo Mountains, *Heller* (*4646*). Known only from Puerto Rico, where it was originally collected by *Schwanecke* and listed as *L. ceratantha* Nees & Mont.

The specimens quoted above have been compared with a portion of the type material of *C. Schwaneckei*, kindly communicated by its author. The species is exceedingly variable, and it is not unusual to find the whole range of variation exhibited by a single plant. The variation shows itself in the apices of the lobes, in the degree of marginal dentation, in the lobules, in the degree of thickening in the walls of the leaf-cells, in the presence or absence of ocelli. It is in the underleaves, however, that it reaches its height. In some cases these are orbicular, scarcely wider than the stem and cuneate at the base; in other cases they are broadly reniform, six times as wide as the stem and deeply cordate at the base. Between these two extremes there are all possible gradations. The bracts and bracteoles are also variable with respect to shape and degree of dentation, but they agree in being always connate with one another, thus forming a second and deeply lobed sheath around the true perianth. The horns of the latter organ do not vary to any extent except in the direction which they assume.

The utriculi are often found at the base of short and simple branches, the remaining leaves of which have spherical lobules and reduced lobes (FIGURE 4). Lobules of this sort, however, are by no means confined to such positions but frequently occur on leaves with normal lobes, either on the main stem or on leading branches.

It is not difficult to distinguish *C. Schwaneckei* from any one of the preceding species. From *C. spinosa* it may be separated by its less strongly toothed leaves and bracts, by the fact that it often develops lobules of the normal type, by the variability in the shape of its underleaves and by the tapering horns of its perianth. From *C. valida* and *C. brevinervis* it may be distinguished by the rounded thickenings of its leaf-cells, by the spherical lobules which it so often develops and by its variable underleaves.

CERATOLEJEUNEA VARIABILIS (Lindenb.) Schiffn.

Lejeunea variabilis Lindenb.; G. L. & N. Syn. Hep. 399. 1845.

Colura variabilis Trevis. Mem. r. Ist. Lomb. III. **4**: 402. 1877.

Lejeunea (*Cerato-Lejeunea*) *variabilis* Spruce, Hep. Amaz. et And. 206. 1884.

Ceratolejeunea variabilis Schiffn.; Engler & Prantl, Nat. Pflanzenfam. **1**^{3}: 125. 1893.

On bark of trees, on rotten logs, on living leaves and on rocks. Without definite localities, *Schwanecke*, *Sintenis*. The species is said to be widely distributed in the American tropics, and the following stations may be quoted: St. Kitts, the type locality, *Breutel;* Dominica, *Elliott;* Martinique, *Husnot;* St. Vincent, *Elliott;* region of the Amazon, *Spruce*. No specimens from Puerto Rico have been seen by the writer.

C. variabilis is very closely related to the preceding species but differs from it in its autoicous inflorescence. Whether this single difference is sufficient to separate the species is a question which cannot be answered definitely at the present time.

CERATOLEJEUNEA SINTENISII Steph.

Lejeunea cornuta Steph. Hedwigia **27**: 285. 1888. (Not Lindenb.)

Ceratolejeunea Sintenisii Steph. Hedwigia **34**: 237. 1895.

Olive-brown, prostrate and loosely adherent to the substratum: stems 0.1 mm. in diameter, elongated, densely and irregularly pinnate, the branches mostly short and widely spreading, sometimes with smaller leaves than the stem: leaves imbricated, the lobe convex and more or less inflexed at the apex, falcate-ovate, 0.7 mm. long, 0.45 mm. wide, antical margin arching across the axis, rounded from very near the base to the apex, postical margin straight or nearly so, apex broad, rounded or bluntly pointed, margin entire or very minutely crenulate from projecting cells, sometimes angular-repand in the outer part; lobule conforming to the normal type, strongly inflated, broadly ovate in outline, 0.12 mm. long, 0.09 mm. wide, keel arched, almost smooth, forming an obtuse angle with the postical margin of the lobe, free margin of lobule somewhat curved, apical tooth short and blunt, slightly curved, papilla in a shallow depression, sinus lunulate; utriculi occasionally present at the base of short branches, occurring singly, 0.35 mm. long; cells of lobe averaging 13μ at the margin, 20μ in the middle and 30 × 20μ at the base, trigones large, triradiate and rounded at the ends of the rays, often confluent, intermediate thickenings occasional, oval; ocelli developed singly or in pairs at the base of the lobe, 46 × 23μ, not always present: underleaves imbricated, plane or convex from below, reniform, maximum size 0.5 × 0.7 mm., rounded to cordate at the base, bifid one fourth to one half with erect, acute to obtuse divisions and a narrow sinus, margin entire or nearly so: inflorescence autoicous: female branch variable in length and sometimes much abbreviated, the flower innovating on one side with a short and often floriferous innovation; bracts complicate, obliquely spreading, the lobe ovate to obovate, 0.6 mm. long, 0.45 mm. wide, rounded to obtusely pointed, entire or minutely crenulate, lobule oblong or ovate, 0.45 mm. long, 0.15 mm. wide, rounded to acute, entire or nearly so; bracteole slightly connate on both sides, broadly ovate, 0.6 mm. long, 0.5 mm. wide, bifid one fourth to one third with erect acute lobes and narrow sinus, margin entire or minutely crenulate; perianth about half exserted, ovoid, 0.85 mm. long, 0.35 mm. wide, beak short, surface smooth except along keels, horns about 0.15 mm. long, terete, tapering to blunt points, obliquely spreading: ♂ inflorescence occupying a short branch; bracts loosely imbricated, in three to six pairs, strongly inflated, shortly and subequally bifid, the lobes blunt; bracteoles present at base of spike, rotund, shortly bifid: mature sporophyte not seen.

Near Jabucoa, *Sintenis* (*125*), the type locality.

The description given above is drawn from a portion of the type specimen kindly communicated by Stephani. Although this specimen shows that the species is probably distinct, it does not bring out clearly the range of variation, and it may be necessary to modify the description in certain details when the plant becomes better known. For this reason it has seemed inadvisable to figure the species at the present time.

C. Sintenisii is somewhat smaller than the preceding species and is more densely pinnate. In its autoicous inflorescence it agrees with *C. variabilis* but differs from all the other species known from the island. It may also be distinguished by the absence of teeth on the leaves and bracts and by the shorter horns of the perianth.

Ceratolejeunea patentissima (Hampe & Gottsche)

Lejeunea patentissima Hampe & Gottsche, Linnaea **25**: 355. 1852.

Lejeunea (*Harpalejeunea*) *patentissima* Steph. Hedwigia **27**: 288. 1888.

Dark olive-brown, scattered: stems 0.08 mm. in diameter, irregularly pinnate, the branches obliquely spreading, not microphyllous: leaves loosely imbricated, the lobe subsquarrose, convex, strongly falcate, broadly ovate or subrotund beyond the lobule, 0.35 mm. long, 0.3 mm. wide, antical margin straight or slightly incurved near base, then very strongly outwardly curved to the apex, postical margin much shorter, more or less curved, apex broad, rounded or apiculate, margin entire or vaguely crenulate from projecting cells; lobule of the normal type, strongly inflated, narrowly ovate in outline, 0.17 mm. long, 0.08 mm. wide, strongly curved forward in the outer part with a narrow tubular opening into the water-sac, keel somewhat arched, slightly roughened, forming approximately a right angle with the postical margin of the lobe, free margin of lobule slightly curved, apical tooth rather long and tapering, abruptly curved at the base, normally reaching to the end of the keel, papilla in a distinct depression, sinus short and shallow; cells of lobe averaging 13 μ at the margin, 18 μ in the middle and 28 × 18 μ at the base, trigones large and often confluent, triradiate and with truncate rays, intermediate thickenings occasional, also truncate, walls often appearing uniformly thickened on account of the minute pits; ocellus when present single, at base of lobe, 41 × 25 μ: underleaves distant, appressed to distinctly squarrose, orbicular, 0.2 mm. long, bifid about one third with an acute sinus and erect or subconnivent, obtuse to acute lobes, margin entire or nearly so: inflorescence dioicous: ♀ inflorescence innovating on one side; bracts complicate, obliquely spreading, the lobe very much as in the leaves with the antical margin much longer than the postical, 0.7 mm. long, 0.5 mm. wide, lobule (in single specimen seen) obovate, 0.5 mm. long, 0.2 mm. wide, broad and apiculate at the apex, entire; bracteole connate on both sides, ovate, 0.6 mm. long, 0.4 mm. wide, bifid about one third with narrow sinus and erect lobes, acute or obtuse at the apex; perianth almost immersed, obovoid, 0.7 mm. long, 0.45 mm. wide, beak short, horns short and rounded, scarcely flattened, suberect: antheridial spike (the only one seen) occupying a short branch; bracts in three pairs, shortly and subequally bifid with rounded or obtuse lobes; bracteole single at base of spike, similar to the underleaves. (PLATE 20, FIGURES 19–26.)

Mixed with other bryophytes. Puerto Rico, *Schwanecke*. The species has apparently not been collected on the island a second time. It has, however, been found in Cuba by *Wright*, and a few fragments of it occur in the writer's set of the *Hepaticæ Cubenses*, mixed with the specimens distributed as *Lejeunea ceratantha*. It has not been reported from any other localities.

Reference has already been made to this species in the discussion of the genus *Harpalejeunea*.* Unfortunately the specimens preserved as the type do not agree in all respects with the original description, the most important discrepancy being with regard to the perianth, which is said to be five-keeled at the apex. The single perianth studied by the writer is in the Hampe herbarium and is mounted on mica, so that it was apparently seen by the authors of the species. This perianth, as shown by FIGURE 21, has four blunt horns, and it would therefore appear that the original description is incorrect in attributing to the plant a five-keeled perianth. Stephani † has described a specimen of this species, also presumably a part of the type, which differs somewhat from the normal form. This specimen is said to have distant leaves with the lobe squarrose, ovate-lanceolate, and sharply pointed. A drawing of this peculiar plant, which he has kindly supplied, shows these differences clearly but agrees with the specimens described above in its lobules and underleaves. Whether it represents an admixture of another species or is simply a slender and poorly developed form of *C. patentissima* can hardly be determined.

C. patentissima is the smallest form of the genus known from Puerto Rico. The slender lobule, distinctly curved forward in the outer part, is perhaps its most striking feature. At the junction with the lobule the postical margin of the lobe curves abruptly inward, the consequence being that the outer end of the water-sac, enclosing the tubular canal, seems to be entirely free from the lobe (FIGURE 19). The true conditions can be made out only by dissection. The lobule apparently exhibits no modifications, neither spherical lobules nor utriculi having been observed. Aside from the peculiarities in the lobule, the species is remarkable for its squarrose and strongly falcate lobes, for the lack of teeth on its leaves and bracts and for its small orbicular underleaves. The walls of the leaf-cells, also, are unusual on account of their minute pits, many of the cells being apparently thick-walled throughout (FIGURE 22).

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* Bull. Torrey Club 30: 547. 1903.

† Hedwigia 27: 288. 1888.

It will be seen from the foregoing discussion that our knowledge of the species in this difficult genus is still far from complete. At the present time it is often quite impossible to determine whether differences are specific in value or merely due to variation. Apparently the plants will have to be studied in the field as well as in the laboratory, to learn if possible something about the causes which induce variation in them, before we can hope for definite conclusions on certain disputed points.

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Explanation of plates 19 and 20

The figures were drawn by the writer and prepared for publication by Miss Hyatt.

PLATE 19

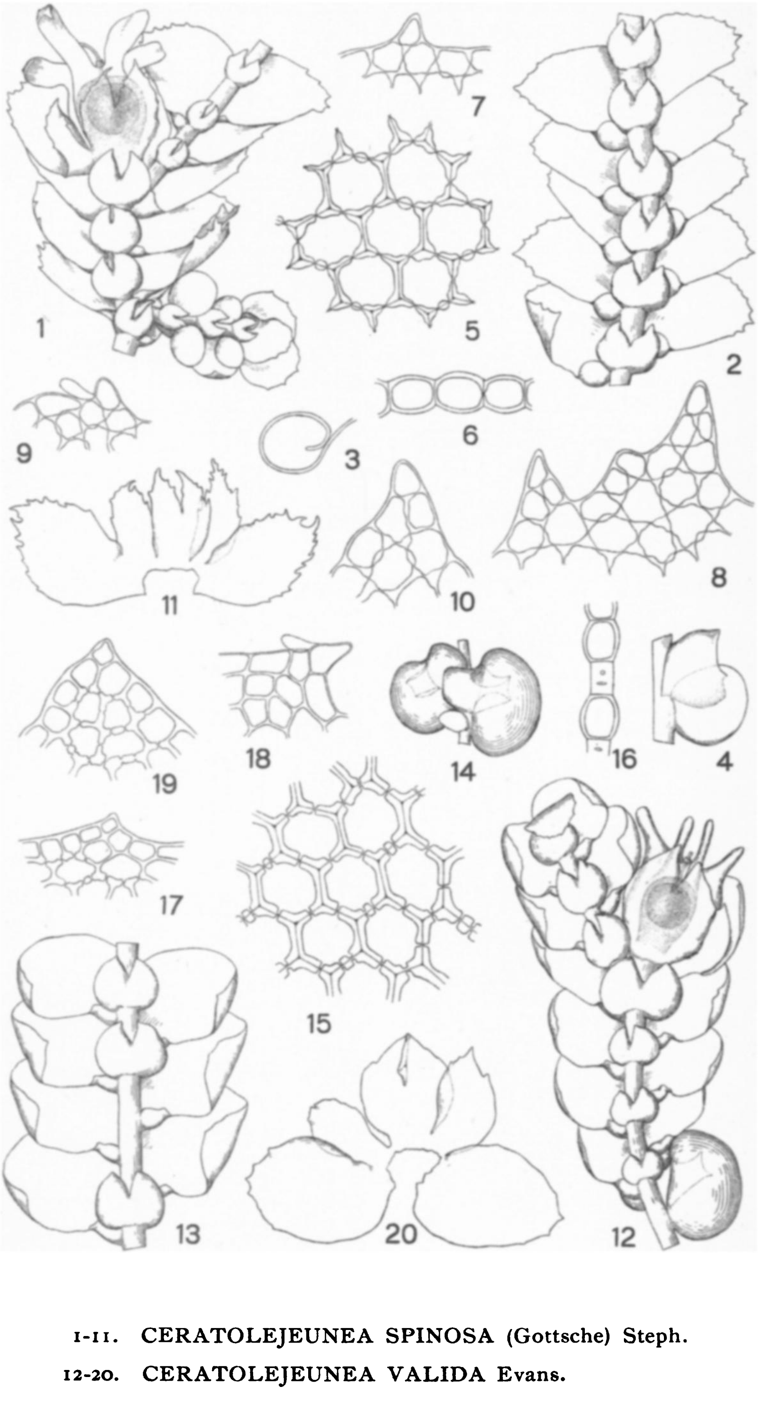
Ceratolejeunea spinosa (Gottsche) Steph. 1. Part of plant with perianth, postical view, × 24. 2. Part of stem, postical view, × 24. 3. Section through lobule, cut parallel with the stem, × 45. 4. Utriculus, antical view, × 35. 5. Cells from middle of lobe, × 265. 6. Section through cells of lobe, × 200. 7. Cells from antical margin of lobe, × 200. 8. Cells from apex of lobe, × 200. 9. Apex of lobule, × 200. 10. Apex of underleaf division, × 200. 11. Bracts and bracteole, × 24. The figures were all drawn from specimens collected by the writer (*97*).

Ceratolejeunea valida Evans. 12. Branch with perianth, postical view, × 24. 13. Part of stem, postical view, × 24. 14. Base of branch with utriculi, antical view, × 24. 15. Cells from middle of lobe, × 265. 16. Section through cells of lobe, × 200. 17. Apex of lobe, × 200. 18. Apex of lobule, × 200. 19. Apex of underleaf division, × 200. 20. Bracts and bracteole, × 24. The figures were all drawn from the type specimen.

PLATE 20

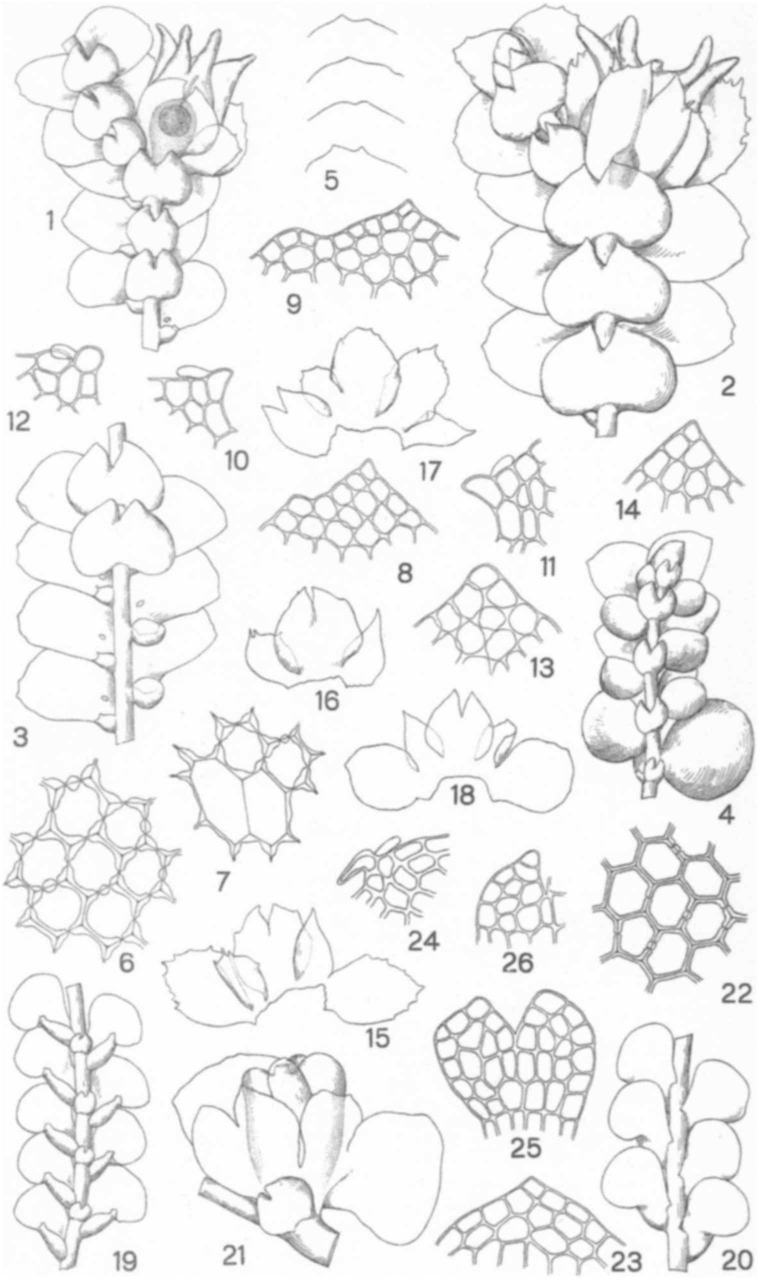
Ceratolejeunea Schwaneckei Steph. 1. Branch with perianth, postical view, × 24. 2. Another branch with perianth, postical view, × 35. 3. Part of stem, postical view. × 24. 4. Branch with utriculi, postical view, × 35. 5. Apices of lobes, × 45. 6. Cells from middle of lobe, × 265. 7. Cells from base of lobe with two ocelli, × 200, 8, 9. Apices of lobes, × 200. 10, 11. Apices of normal lobules, × 200. 12. Apex of spherical lobule, × 200. 13, 14. Apices of underleaf divisions, × 200. 15. Bracts and bracteole, × 24. 16. Bracteole with lobules of bracts, × 24. 17. Bracts and bracteole, the latter on the left, × 24. 18. Bracts and bracteoles, × 24. The figures were all drawn from specimens collected by the writer (*26*, *146* and *189*).

Ceratolejeunea patentissima (Hampe & Gottsche) Evans. 19. Part of stem, postical view, × 35. 20. Part of stem, antical view, × 35. 21. Perianth with bracts and bracteole, × 35. 22. Cells from middle of lobe, × 265. 23. Apex of lobe, × 200. 24. Apex of lobule, × 200. 25. Underleaf, × 200. 26. Apex of underleaf division, × 200. Figures 22 and 24 were drawn from Wright's Cuban specimens; the others were all drawn from the type specimen.



1-11. CERATOLEJEUNEA SPINOSA (Gottsche) Steph.

12-20. CERATOLEJEUNEA VALIDA Evans.



1-18. CERATOLEJEUNEA SCHWANECKEI Steph.

19-26. CERATOLEJEUNEA PATENTISSIMA (Hampe & Gottsche) Evans.